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NASA News

National Aeronautics and
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Washington, D.C. 20546
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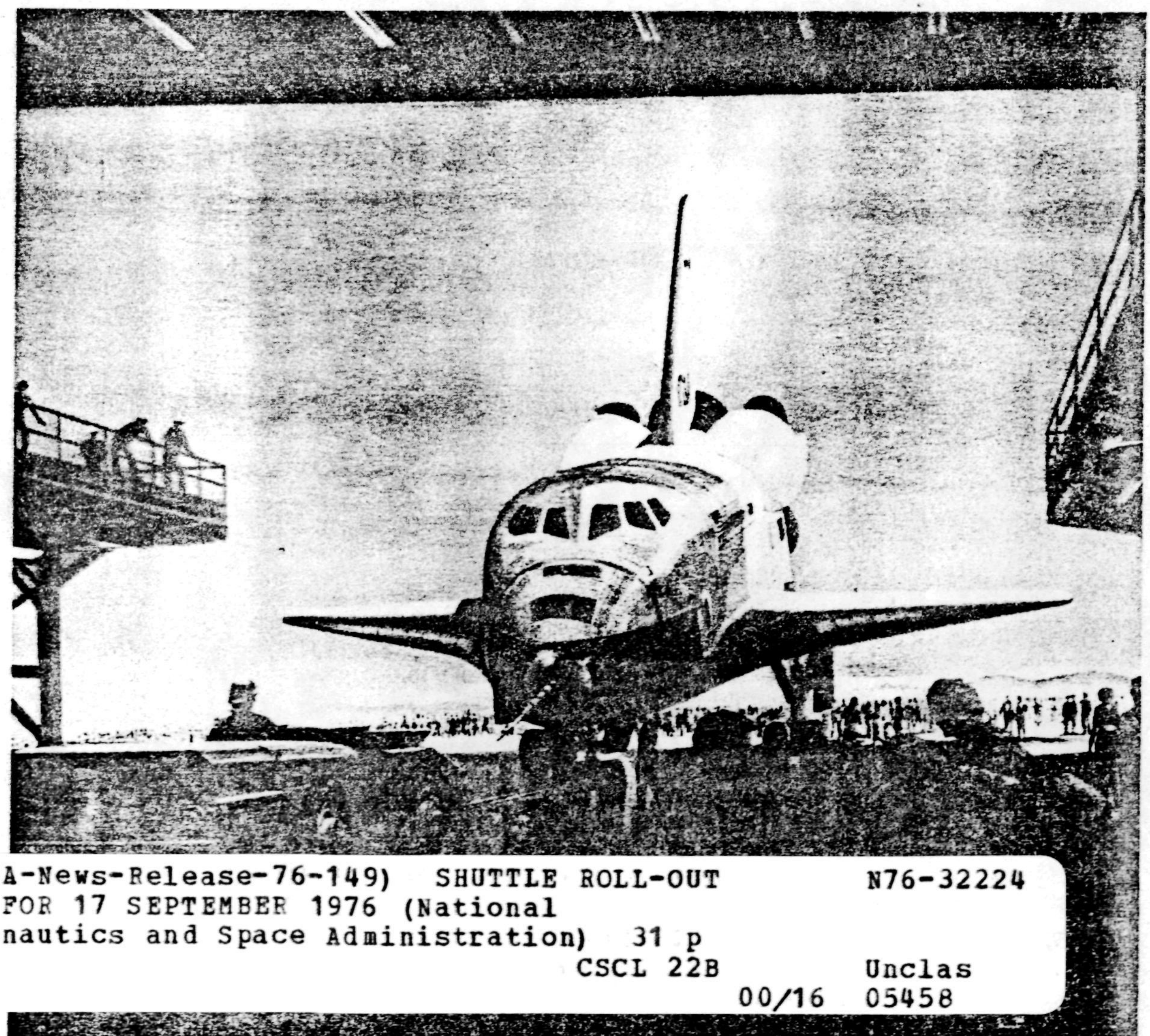
Press Kit

Project SPACE SHUTTLE ROLL-OUT

RELEASE NO: 76-149



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CONTENTS

GENERAL RELEASE.................................. 1-7

SPACE SHUTTLE ORBITER - OV 101
CHRONOLOGICAL EVENTS............................. 8-10

SPACE TRANSPORTATION SYSTEM...................... 11

APPROACH AND LANDING TESTS....................... 12-13

CARRIER AIRCRAFT................................. 14-19

APPROACH AND LANDING TEST TIMELINE.............. 14

TENTATIVE FREE FLIGHT PLAN....................... 20-21

SPACE SHUTTLE ALT CREWS.......................... 22

747 CARRIER AIRCRAFT CREW........................ 23

GROUND VIBRATION TESTS........................... 24-25

PROGRAM MANAGEMENT............................... 26

SPACE SHUTTLE PROGRAM OFFICIALS.................. 27-29

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IMMEDIATE

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RELEASE NO: 76-149

SHUTTLE ROLL-OUT SET FOR SEPT. 17

The Flagship of the new era of space transportation will be unveiled at Palmdale, Calif., Sept. 17, 1976, when Orbiter 101, the first reusable Space Shuttle vehicle is put on public display by the National Aeronautics and Space Administration. The Space Shuttle, a versatile and reusable spacecraft, is scheduled to begin Earth orbital flights in 1979.

- more -

National, state and local officials have been invited to attend the rollout and unveiling of the Orbiter, at the NASA Rockwell International Space Division assembly plant at Palmdale. Congressional leaders and NASA officials will take part in the program which is scheduled to begin at 9:30 a.m. PDT Sept. 17.

Although Orbiter 101 is the first vehicle off the assembly line, it will not fly into space until the early 1980s. Its first job in 1977 will be as a test vehicle. It will be launched from the top of a modified 747 jetliner in a series of manned flights (Approach and Landing Tests - ALT) to verify its aerodynamic and flight control characteristics at NASA's Dryden Flight Research Center (DFRC), Edwards Air Force Base, Calif. Subsequent to ALT, extensive ground vibration tests will be conducted in 1978 at NASA's Marshall Space Flight Center (MSFC), Huntsville, Ala. When these tests are concluded, Orbiter 101 will be returned to Palmdale, Calif., for modifications to prepare it for space flight. The second Orbiter (OV-102) will be used in the initial Earth orbital flights from NASA's Kennedy Space Center, Fla., in 1979.

The Orbiter, workhorse of the Space Shuttle program, is designed to be used as many as 100 times. It is as large as a commercial jet airliner (DC-9); its empty weight is 67,500 kilograms (150,000 pounds); it is 45 meters (122 feet) in length and it has a wingspan of 14.4 meters (78 feet).

The Space Shuttle is composed of the Orbiter, two solid rocket boosters and an external fuel tank which feeds the Orbiter's three main engines. The Orbiter is attached to the back of the fuel tank and the solid boosters are attached to each side of the external tank. The solid rocket boosters will be recovered, refurbished and reused. The external tank will be jettisoned but not recovered.

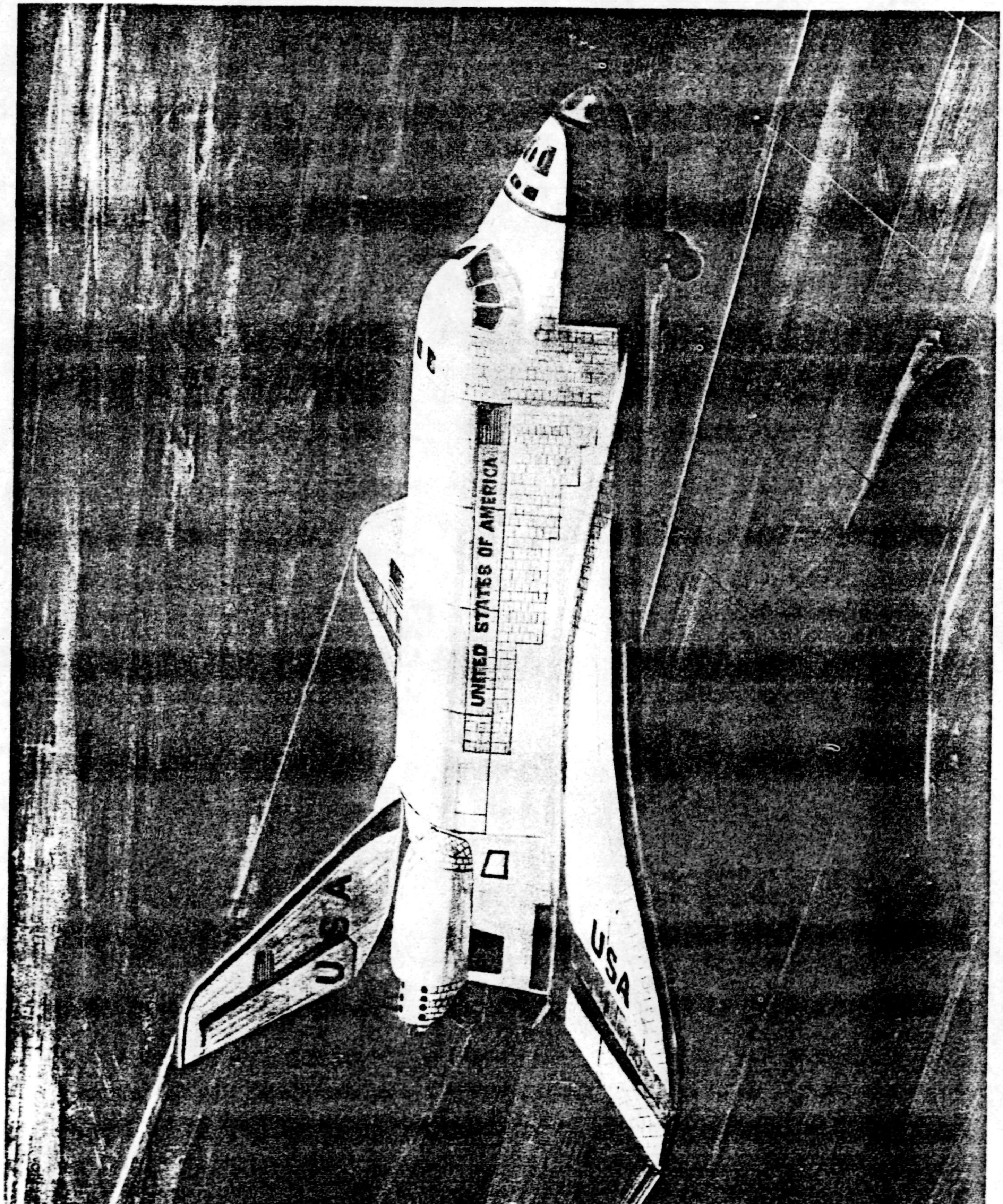
The Orbiter is capable of carrying inside its 60-foot-long and 15-foot-wide cargo bay, a 29,250 kg (65,000 lb.) payload into low Earth orbit about 320 kilometers (200 miles) altitude.

The Orbiter will be launched as a rocket and, after its Earth orbital mission is completed, will return to Earth and land like an aircraft at designated runways in California or Florida.

Under construction since June 19, 1974, the Orbiter's main parts come from numerous aerospace contractors throughout the country. The crew module and aft fuselage were fabricated by the prime contractor, Rockwell International's Space Division, Calif.; the mid fuselage (cargo bay) by General Dynamics, San Diego, Calif.; wings by the Grumman Aerospace Corporation of Bethpage, N.Y.; and its tail assembly by the Fairchild Republic Company, Farmingdale, N.Y. The Orbiter's three main engines, which provide 211,500 kg (470,000 lb.) of thrust each at launch, are being built by the Rocketdyne Division, Rockwell International, Canoga Park, Calif.

Late in Jan. 1977, Orbiter 101 will be moved from Palmdale to nearby DFRC, a distance of 56 km (35 mi.), where approach and landing tests will be conducted.

(END OF GENERAL RELEASE. BACKGROUND INFORMATION FOLLOWS.)



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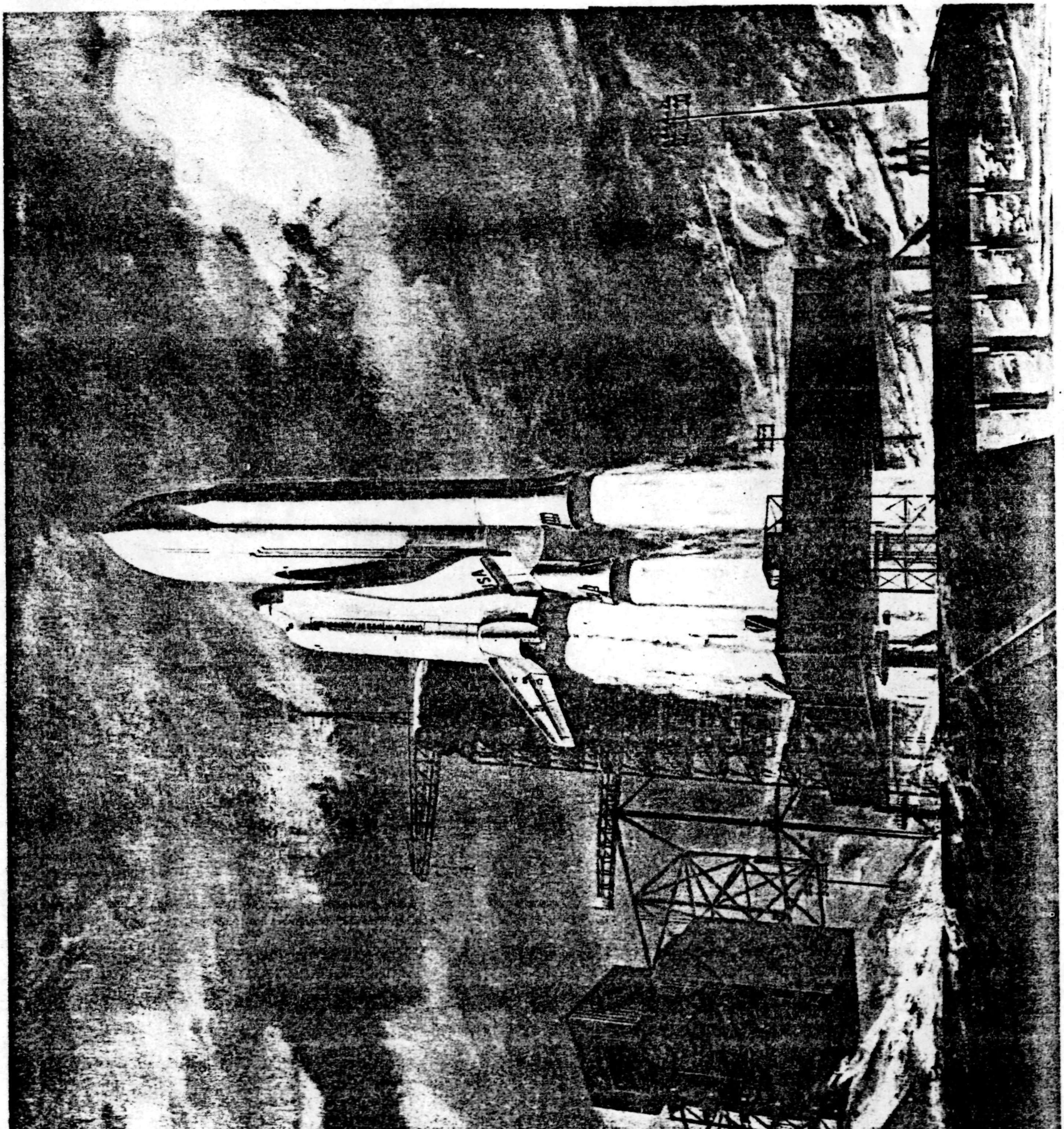

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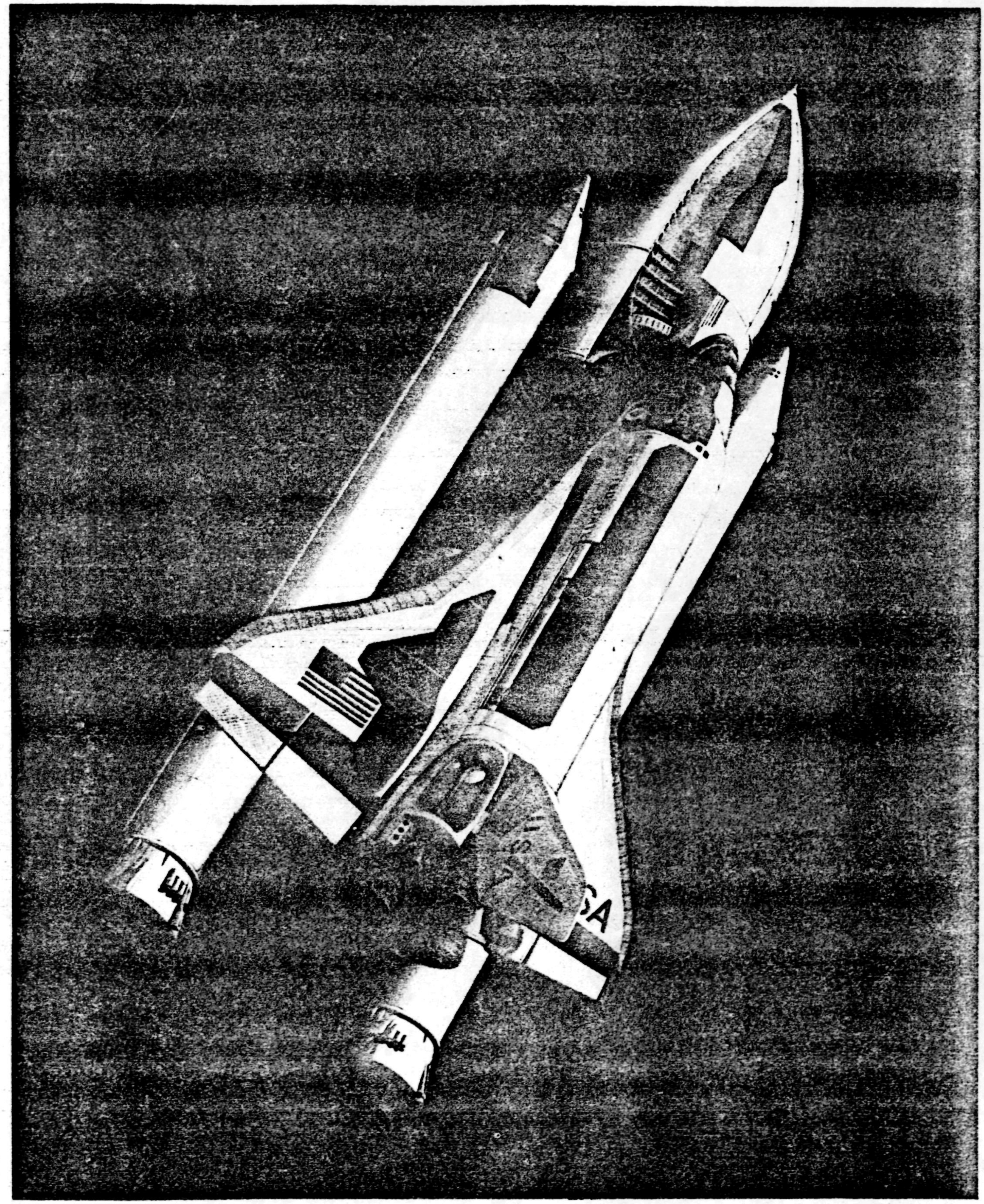
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SPACE SHUTTLE ORBITER - OV 101

CHRONOLOGICAL EVENTS

Aug. 9, 1972	NASA gives authority to proceed on Space Shuttle Orbiter contract. (Selection of Rockwell International's Space Division announced July 16, 1972.)
June 4, 1974	Orbiter Vehicle OV 101-Start structural assembly of crew module (Downey)
Aug. 26, 1974	OV-101-Start structural assembly of aft fuselage (Downey)
Mar. 27, 1975	OV-101-Mid fuselage (General Dynamics, San Diego) delivered to Palmdale facility
May 23, 1975	OV-101-Wings (Grumman, N.Y.) delivered to Palmdale facility
May 25, 1975	OV-101-Vertical stabilizer (Fairchild, N.Y.) delivered to Palmdale facility.
Aug. 25, 1975	OV-101-Start final assembly and mating (Palmdale)
Sept. 9, 1975	OV-101-Aft fuselage (Space Division) delivered to Palmdale
Oct. 31, 1975	OV-101-Lower forward fuselage (Space Division) delivered to Palmdale
Nov. 17, 1975	OV-102-Start fabrication of crew module (First orbital flight vehicle)
Dec. 1, 1975	OV-101-Upper forward fuselage (Space Division) delivered to Palmdale
Jan. 16, 1976	OV-101-Crew module (Space Division) delivered to Palmdale
Mar. 3, 1976	OV-101-Cargo bay doors (Tulsa Division) delivered to Palmdale
Mar. 12, 1976	OV-101-Complete final assembly and close-out systems installation (Palmdale)

- more -

Mar. 15, 1976	OV-101-Start functional checkout (Palmdale)
April 19, 1976	OV-102-Start assembly of forward fuselage (Downey)
June 1976	OV-102-Start assembly of crew module (Downey) OV-101-Complete functional checkout (Palmdale) OV-101-Start ground vibration and proof load tests (Palmdale)
Aug.-Sept. 1976	OV-102-Start assembly of forward fuselage (Downey) NASA 747 (Boeing ferry aircraft)-Structural modification (Seattle)
Sept. 17, 1976	Rollout first Space Shuttle Orbiter (OV-101) (Palmdale) OV-102-Start assembly of aft fuselage (Downey)
Oct.-Nov. 1976	OV-101-Start retest (Palmdale) NASA 747-Complete modification OV-101-Complete integrated systems checkout (Palmdale)
Jan.-Feb. 1977	OV-101-Configuration inspection (Palmdale) OV-102-Deliver mid fuselage to Palmdale OV-101-First captive flight with NASA 747 (Dryden)
July-Aug. 1977	OV-101-First free flight approach and landing test (ALT) (Dryden) OV-102-Start final assembly and closeout systems installation (Palmdale) OV-102-Deliver lower and upper forward fuselage and aft fuselage to Palmdale OV-102-Deliver wings to Palmdale
Sept.-Oct. 1977	OV-102-Deliver crew module, vertical stabilizer, and body flaps to Palmdale
Nov. 1977	OV-102-Complete final assembly and close-out systems installation (Palmdale) OV-102-Start functional checkout (Palmdale)
Jan. 1978	OV-101-Complete free flight tests
Mar. 1978	OV-101-Deliver orbiter to Marshall Space Flight Center, Ala. (MSFC) (ferried by NASA 747) for vertical ground vibration test

Apr. 1978	OV-101-Start vertical ground vibration test (MSFC)
May 1978	OV-101-Deliver external tank for vertical ground vibration test to MSFC Ala.
July 1978	OV-102-Complete configuration inspection (Palmdale) OV-102-Final acceptance rollout (Palmdale)
Aug. 1978	OV-102-Deliver first orbital flight vehicle to Kennedy Space Center (KSC), Fla.
Dec. 1978	OV-101-Complete vertical ground vibration test (MSFC) OV-102-Ready for transfer to Pad 39A (KSC)
Feb. 1979	OV-101-Deliver to Rockwell, Palmdale, and start modification.
Mar. 1979	OV-102-First manned orbital flight, Space Transportation System (KSC)

SPACE TRANSPORTATION SYSTEM

The Space Transportation System of the next decade will consist of the Space Shuttle, Spacelab and upper stages to propel payloads beyond the capability of the Shuttle to synchronous orbit and to the planets.

With the Space Shuttle, the rather large stable of launch vehicles that we use today--both civilian and military--will be eliminated. The Shuttle will be used to place almost all our satellites into orbit and, more importantly, it will have the capability to retrieve malfunctioning satellites and repair them in orbit or return them to Earth. This capability assumes particular importance with the predicted growing future requirements for additional weather, Earth resources, communication, and navigational satellites. No longer will it be necessary to write off a multi-million-dollar satellite due to a malfunction following launch.

The Space Shuttle will be capable of carrying the Spacelab into orbit. Spacelab, carried in the Shuttle cargo bay, provides a shirtsleeve, pressurized environment for scientific and technical investigators to work in space. Airlocks and a pallet external to the pressurized area will be available for experiments that require direct access to the space environment.

For lunar and planetary missions, the Shuttle will be capable of carrying upper stages into Earth orbit which will propel probes and satellites into outer space. These upper stages will also be used to place satellites into high geosynchronous orbits.

APPROACH AND LANDING TESTS

The Orbiter Approach and Landing Tests program is to verify subsonic airworthiness, pilot-guided and automatic approach landing capabilities of the Orbiter. These tests which will be conducted at Dryden Center, Edwards Air Force Base (EAFB), will begin in February 1977, with a series of unmanned and manned flights mated on top of a modified 747 jetliner. (See ALT schedule.)

The first tests call for the 101 vehicle to be placed on top of the 747 for a number of taxi runs on the runway of EAFB. The taxi tests will be followed by six unmanned captive flights where the Orbiter will be carried to an altitude of approximately 7,450 m (25,000 ft.) by the 747 but not released.

These unmanned captive flights will be followed by a series of captive flights with the ALT crew aboard the Orbiter. These tests are designed to verify most of the Orbiter's systems and crew procedures as well as provide some verification of Orbiter dynamics and controlability.

The first manned "free" flights will be conducted in July 1977. The Orbiter will be carried aloft, released from the 747 carrier and flown to an unpowered landing three to four minutes later on the dry lake bed landing strip at EAFB. The 747, specifically modified for these test flights, will carry the Orbiter to an altitude of about 8,400 m (28,000 ft.) It will take about 30 minutes for the 747 to reach this altitude.

The flight path of the Orbiter and 747 follows a race track pattern with separation occuring when the vehicles are about 13 km (8 mi.) to the right, and flying parallel to the landing runway. From the separation point, the Orbiter will fly a "U" shaped ground track to the runway.

To perform the separation maneuver, the 747 will pitch down and accelerate to 250 knots equivalent airspeed (KEAS). The 747 pilot will then reduce engine thrust to idle, deploy the 747 inflight spoilers, and stabilize the vehicles at 260 KEAS, with a flight path of 9 degrees. At this point the Obiter pilot will initiate separation by arming and firing a series of explosive bolts at an altitude of about 6,600 m (22,000 ft.) above runway level.

At separation the Orbiter pilot will command a pitch up maneuver which will provide a vertical separation of more than 66 m (200 ft.) after 5 seconds. The 747 will then turn left while the Orbiter turns right to provide horizontal separation. The Orbiter will pitch down, accelerate to 270 KEAS and then perform a practice flare, allowing the airspeed to decrease to 185 KEAS while evaluating the flying qualities of the Orbiter.

The Orbiter pilot will then pitch down to accelerate and at the same time initiate the first of two 90 degree turns to the left which will align him with the lakebed runway.

At the completion of the second turn, the Orbiter is aligned with the runway at an altitude of 2,150 m (6,500 ft.) and about 98 miles from the touchdown point, speed 270 KEAS, flight path -9 degrees.

First flare (Preflare) starts at an altitude of 270 m (900 ft.), and transfers the Orbiter from the -9 degree glide slope to a -3 degree glide slope. The landing gear is deployed shortly afterward, at about 105 m (350 ft.) altitude, and the landing flare (Final Flare) is initiated at slightly less than 30 m (100 ft.) altitude. The final flare establishes a sink rate of approximately 3 feet per second which is held to touchdown. Touchdown airspeed is about 180 KEAS and elapsed time from separation to touchdown is about 5 minutes 15 seconds.

The combined weight of the 747 and Orbiter is 28,500 kg (570,000 lbs.) The Orbiter will weigh about 67,500 kg (150,000 lbs.) and the 747 (with 34,650kg 977,000 lb.) of fuel will weigh approximately 205,800 kg (420,000 lb.)

CARRIER AIRCRAFT

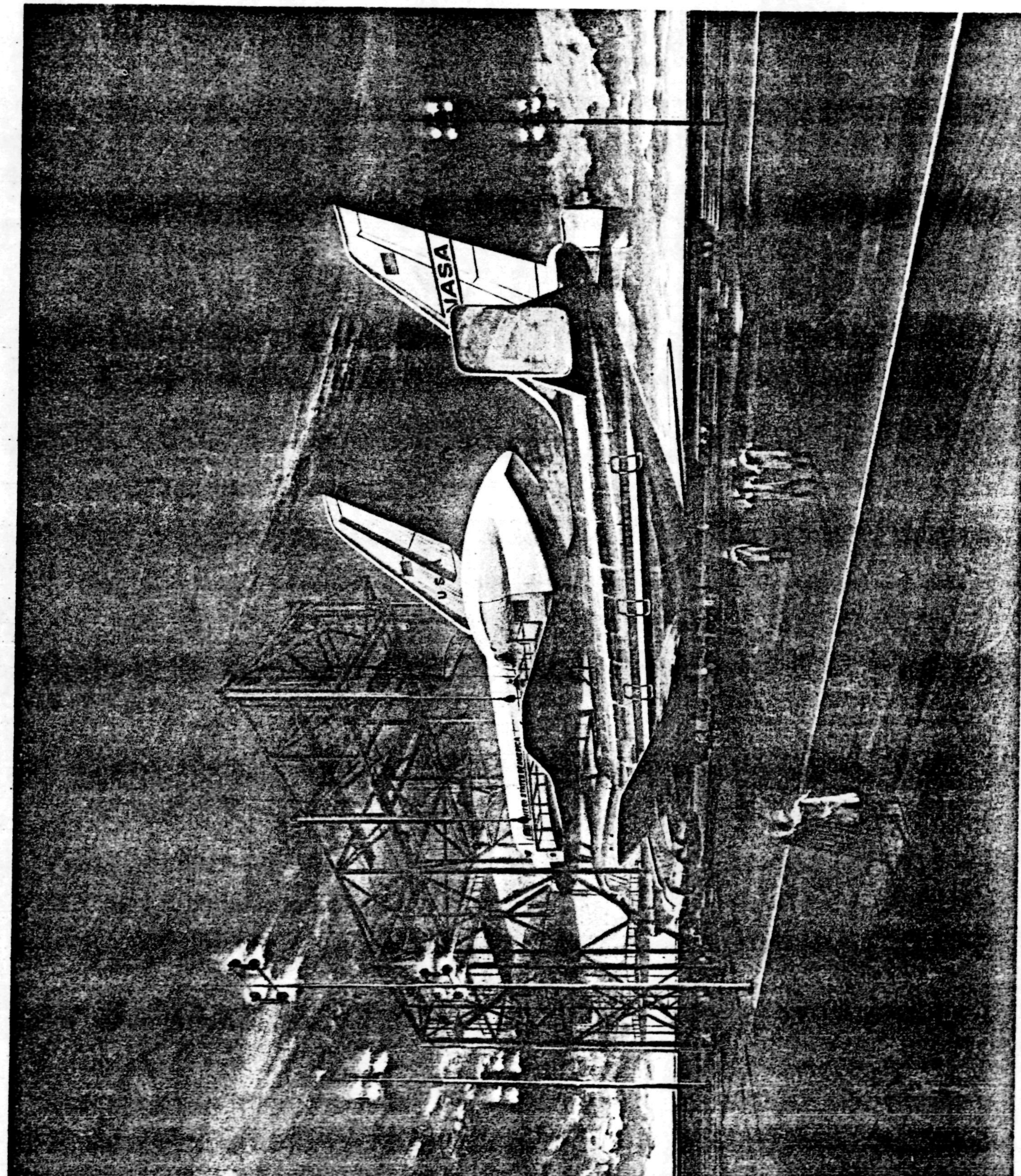
The 747, purchased by NASA in the summer of 1974, is currently being modified at the Boeing Aerospace Company facilities in Everett, Wash. The 231-foot-long aircraft has had the majority of its seats and passenger accommodations removed and replaced by equipment and instruments required to support the Orbiter test flights. Structural modifications include addition of reinforcement frames and panels. Panels and stabilizer tip fins have been attached to the horizontal stabilizer.

Support struts (two aft, one forward) have been added to the aircraft to hold the Orbiter. The Orbiter will be affixed to these points and, at the proper moment in flight, explosive bolts will release the Orbiter from the 747.

In addition to serving as the carrier aircraft for the approach and landing tests, the 747 will ferry the Orbiter from its manufacturing facilities in California, to the NASA KSC launch facilities in Florida. The 747 will also be used to ferry the Orbiter to launch facilities at Vandenberg Air Force Base, near Lompoc, Calif.

APPROACH AND LANDING TEST TIMELINE

Orbiter Vehicle (OV-101) overland to DFRC	January	'77
Taxi-runs and unmanned captive flights (5)	February	'77
Manned captive flights (5)	May	'77
Manned "free" flights (8)	July	'77
Conclude "ferry" flight phase (3)	March	'78
Ferry flight to MSFC, Alabama	March	'78



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ORBITER/SCA MATED CONFIGURATION

ENGINES

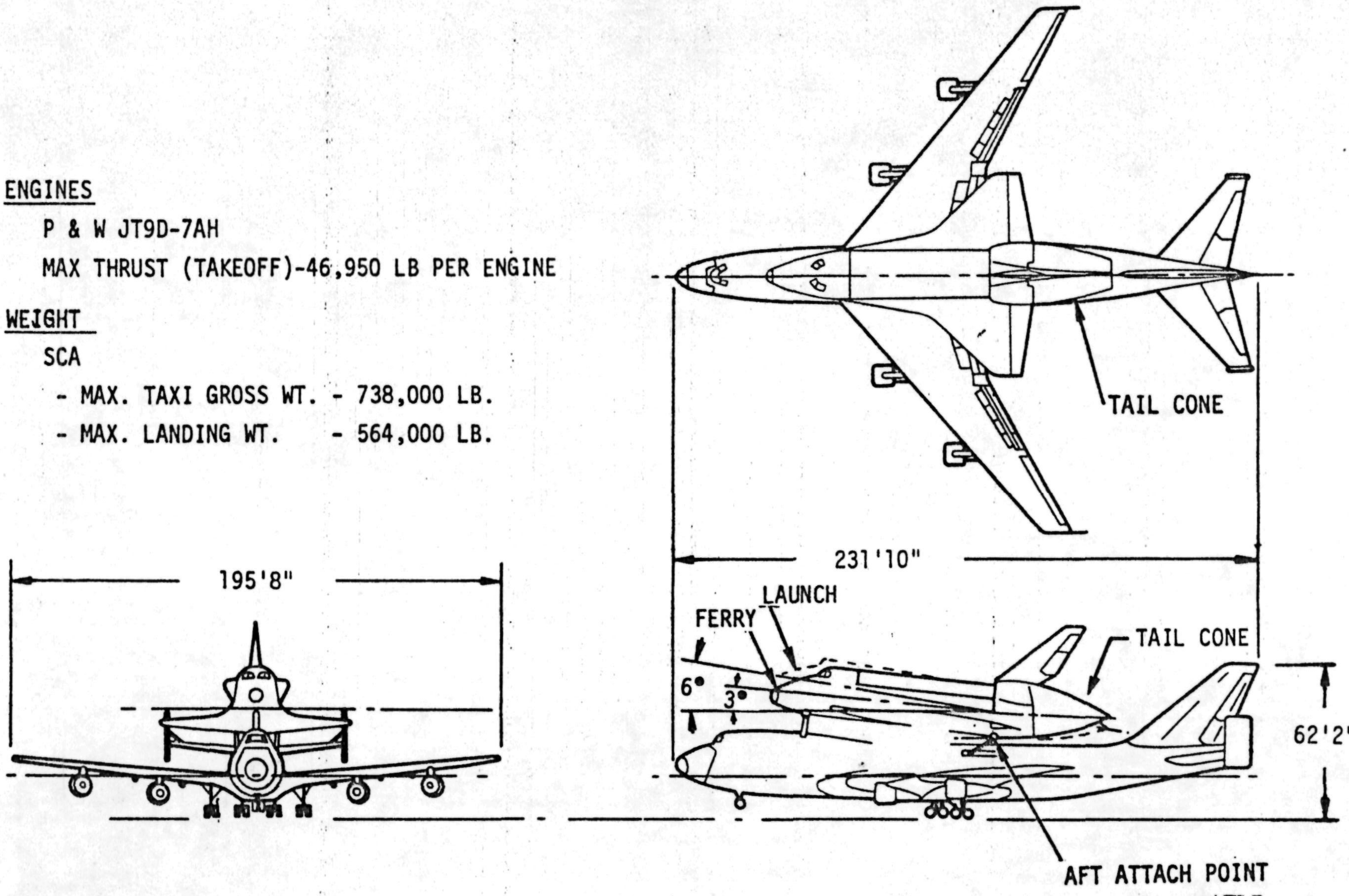
P & W JT9D-7AH

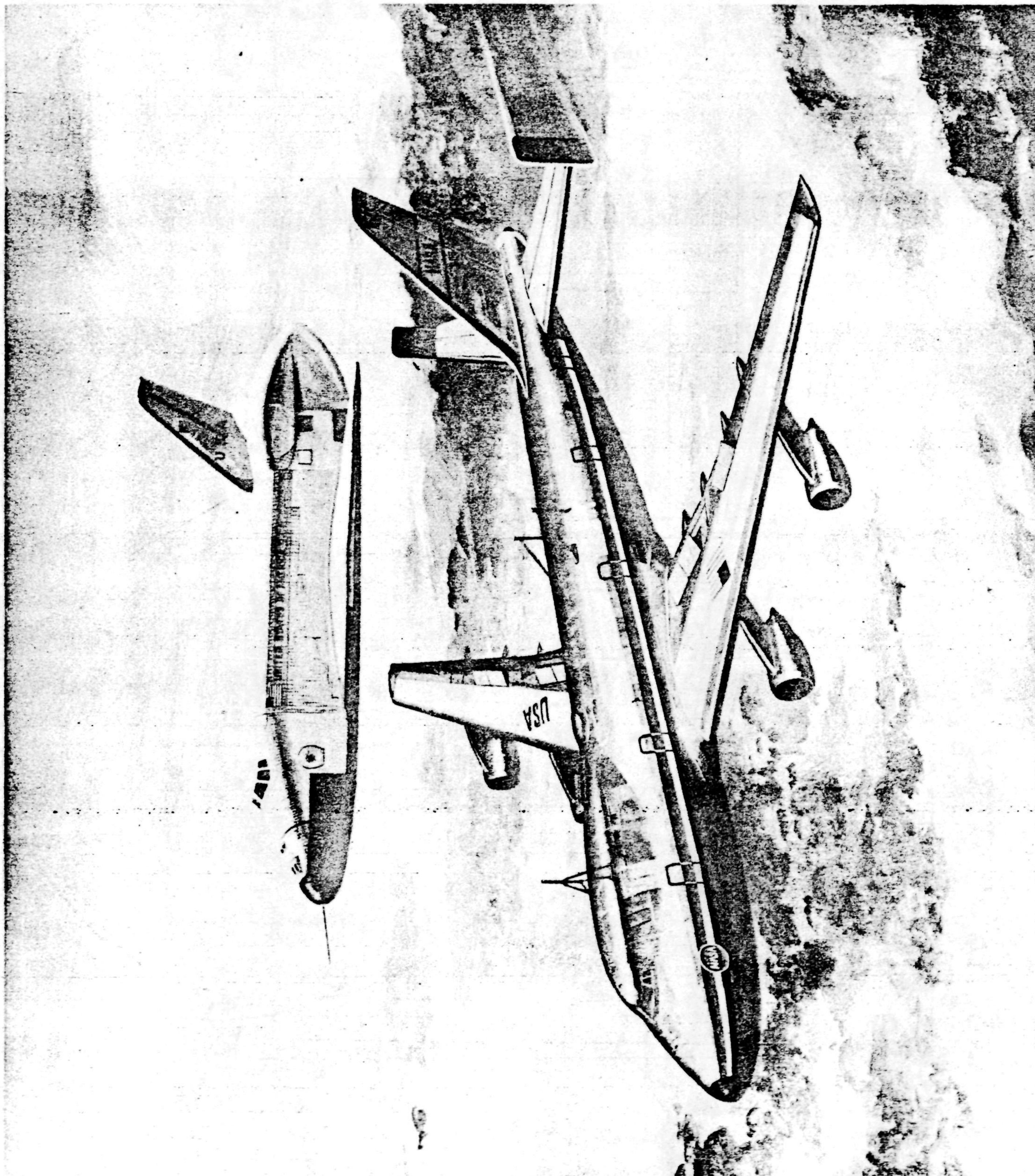
MAX THRUST (TAKEOFF)-46,950 LB PER ENGINE

WEIGHT

SCA

- MAX. TAXI GROSS WT. - 738,000 LB.
- MAX. LANDING WT. - 564,000 LB.





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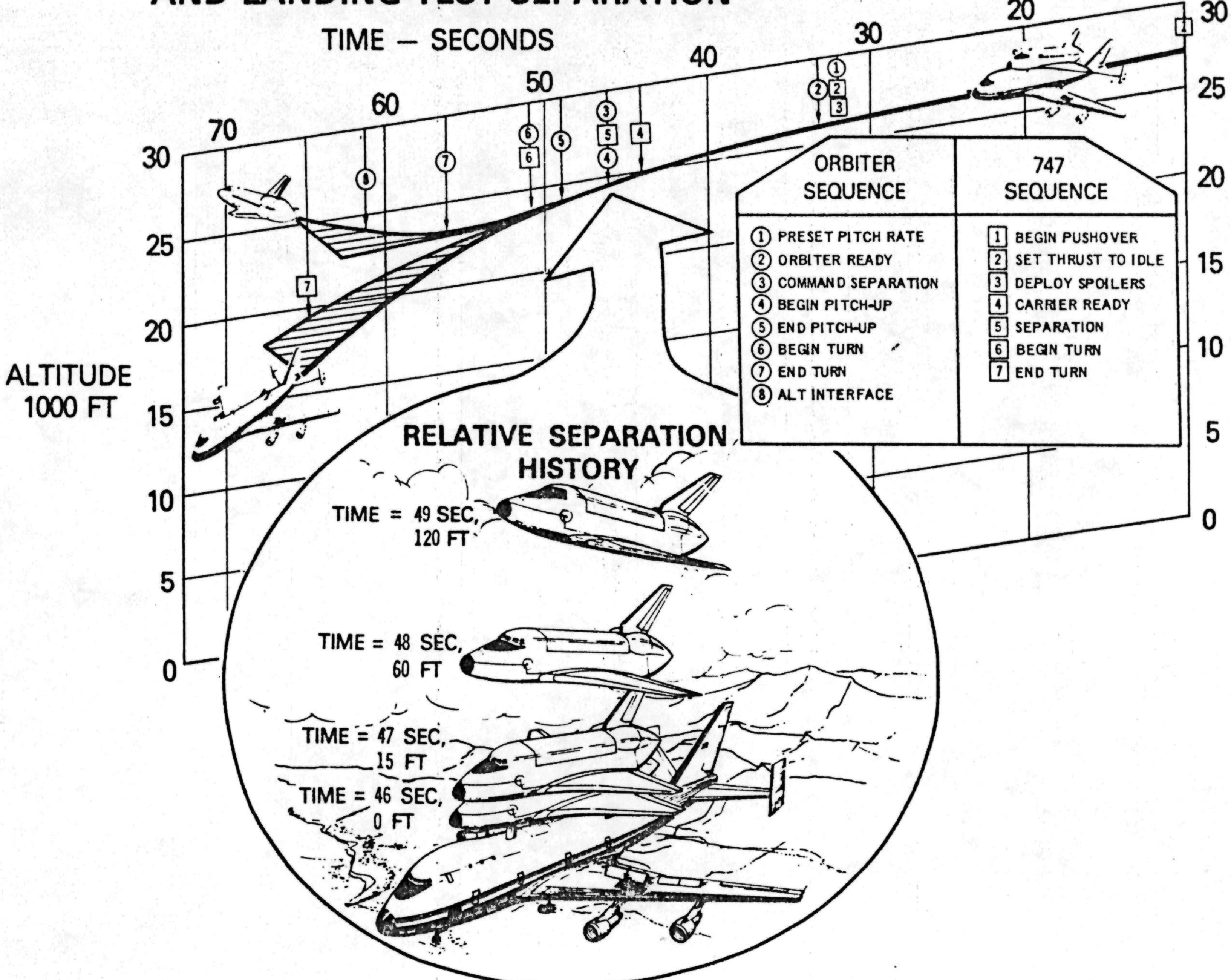
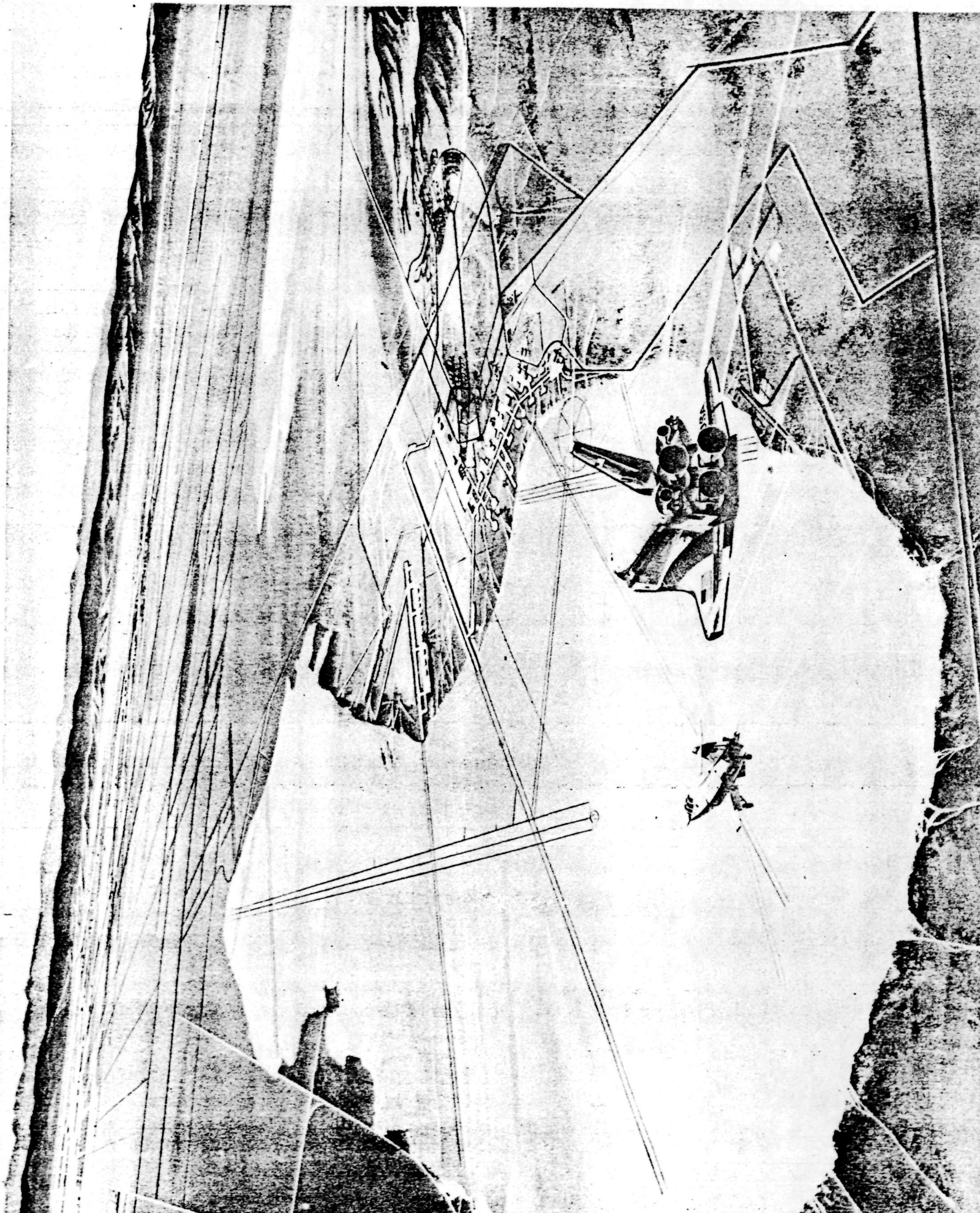
SHUTTLE ORBITER/747 APPROACH AND LANDING TEST SEPARATION





TENTATIVE FREE FLIGHT PLAN

FLIGHT	CONFIGURATION	DESCRIPTION	MAJOR OBJECTIVES
1	Tailcone on	Practice flare at altitude 180 degree turn Lake bed landing	Manual landing Handling qualities Gentle braking Nose wheel steering
2	Tailcone on	Test inputs at 300 kts 1.8g turn Test inputs at 200 kts 45 degree speed brake with inputs Lake bed landing	Test inputs for high speed, low speed, and with speed brake Turn maneuverability Nose wheel steering
3	Tailcone on	Test inputs at 300 kts 1.8g turn Test inputs at 200 kts 35 degree speed brake with inputs Lake bed landing	Test inputs for high speed, low speed, and with speed brake Turn maneuverability Nose wheel steering
4	Tailcone on	FCS mode switching Manual direct FCS 180 degree turn Auto FCS Closed loop auto guidance to above preflare altitude Lake bed landing	Verify FCS* modes and switching Auto guidance Steering with differential braking
5	Tailcone on	180 degree side approach to concrete landing 45 degree speed brake	Concrete landing Braking on paved surface Autoland information
6	Tailcone off	Practice flare at altitude	Manual landing Handling qualities
7	Tailcone off	Auto FCS 45 degree speed brake Closed loop auto guidance to above preflare altitude Speed brake retraction Lake bed landing	Auto guidance Speed brake modulation

- more -

TENTATIVE FREE FLIGHT PLAN (cont'd)

FLIGHT	CONFIGURATION	DESCRIPTION	MAJOR OBJECTIVES
8	Tailcone off	Closed loop auto guidance and speed brake modulation to touchdown Lake bed landing	Auto guidance Auto landing

* FCS - Flight Control Subsystem

SPACE SHUTTLE ALT CREWS

NASA has selected two, two-man crews for the Space Shuttle Approach and Landing Test (ALT), the initial flight test of the Shuttle Program. The ALT free flight tests are scheduled to begin in July 1977.

The two crews are: Fred W. Haise, Jr., commander and Charles G. Fullerton, pilot; Joe H. Engle, commander and Richard H. Truly, pilot. Both crews are scheduled to fly ALT missions with Haise and Fullerton making the first flight.

The crews will participate in the various phases of Orbiter test and checkout between now and the first flight. Both crews will train for the flights using NASA T-38 aircraft with special speed-brake; the Shuttle Training Aircraft, a modified, twin-jet Gulfstream II; Shuttle Procedures Simulator; and the Orbiter Aeroflight Simulator.

Haise, 42 (civilian), commander of the first crew was selected for the astronaut program in April 1966. He was backup lunar module pilot for Apollos 8 and 11, lunar module pilot on Apollo 13 and backup commander on Apollo 16. He is the only crewman named that has flown in space.

Fullerton, 39 (Lieutenant Colonel, USAF), pilot of the first crew, was one of the USAF Manned Orbiting Laboratory Program crewmen selected for the astronaut program in September 1969. He was a member of the support crews for the Apollo 14 and 17 missions.

Engle, 43 (Colonel, USAF), commander of the second crew, was selected for the astronaut program in April 1966. He was a member of the astronaut support crew for Apollo 10 and the backup lunar module pilot for the Apollo 14 mission.

Truly, 38 (Commander, USN), pilot for the second crew, was one of the USAF Manned Orbiting Laboratory Program crewmen selected for the astronaut program in September 1969. He was a member of the support crew for all three Skylab missions.

747 CARRIER AIRCRAFT CREW

Crew members for the 747 carrier aircraft are Fitzhugh L. Fulton, Jr., and Thomas C. McMurty, pilots; Victor W. Horton and Thomas E. Guidry, Jr., flight test engineers. Fulton, McMurty and Horton are from the NASA Dryden Flight Research Center and Guidry is a flight engineer from the NASA Johnson Space Center.

Fulton is a veteran multi-engine test pilot with wide experience as a launch pilot. He was launch pilot for the X-15 and for manned lifting bodies, as well as on other experimental aircraft flight test programs. He was an XB-70 project pilot for NASA and the USAF. Currently Fulton is co-project pilot on the triple-sonic YF-12 flight research program.

McMurty has been flying experimental aircraft for NASA since 1967. As project pilot on the Supercritical Wing, he made the first flight with the new airfoil shape. He has flown as co-project pilot on the Digital Fly-by-Wire aircraft and the Supercritical Wing F-111, and as co-project pilot on NASA's 990 and C-141 multi-engine aircraft.

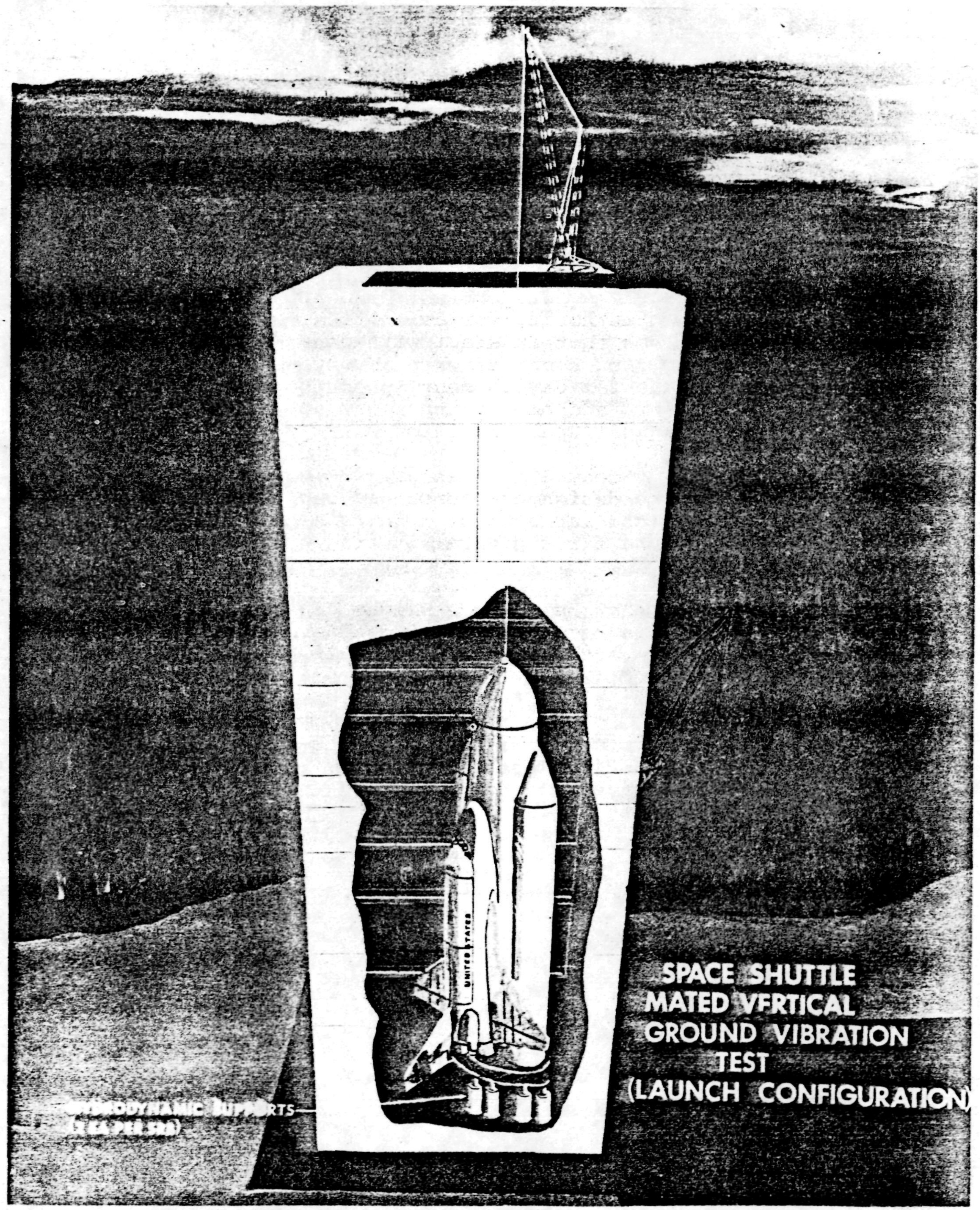
Horton is flight test engineer on the YF-12 at DFRC and has flown as launch-panel operator of the B-52 air-launch aircraft. Guidry of JSC has flown as test engineer on the C-135 Zero-G studies and the C-130 Earth Resources aircraft.

GROUND VIBRATION TESTS

Orbiter 101 will be ferried from DFRC to the Marshall Space Flight Center, Huntsville, Ala., for ground vibration tests in March 1978.

It will be mated in the Dynamic Test Facility at MSFC to the 46-meter (154-foot) tall external tank and solid boosters, as it would for actual launch. The tank in flight will carry the 675,000 kg (1.5 million lbs.) of liquid hydrogen and liquid oxygen propellants for the Orbiter's three main engines. The two solid boosters will be attached to the external tank. This 55-m (184-ft.) tall vehicle will undergo vibration tests which are designed to simulate expected vibration and stress loads during the launch phase, when all the Shuttle engines -- the three main engines of the Orbiter and the two solid boosters -- fire simultaneously furnishing 30 million newtons (6.8 million lbs.) of thrust.

The vibration tests are designed to gain information needed for analysis of flight control stability and dynamic loads during the launch and flight phases of the mission. The tests will be conducted in a modified test stand in which the entire 109-m (363-ft.) tall Apollo Saturn V underwent similar vibration tests in the mid 1960's.


HYDRODYNAMIC SUPPORTS
SPACE SHUTTLE
MATED VERTICAL
GROUND VIBRATION
TEST
(LAUNCH CONFIGURATION)

PROGRAM MANAGEMENT

Overall direction of the Space Shuttle Project is in the Office of Space Flight at NASA Headquarters, Washington, D.C. This office is responsible for the detailed assignment of responsibilities, basic performance requirements, control of major milestones and funding allocations to the various NASA field centers.

The Lyndon B. Johnson Space Center (JSC), Houston, Tex., is the Space Shuttle lead center and as such has responsibility for overall program management, overall systems engineering and systems integration. JSC also has overall responsibility and authority for definition of those elements of the total systems that interact with other elements, such as total configuration combined with aerodynamic loads. JSC is also responsible for development, production, and delivery of the Shuttle Orbiter, and manages the contract with the Rockwell International Space Division.

The John F. Kennedy Space Center (KSC), Florida, is responsible for the design of launch and recovery facilities and will serve as the launch site. Edwards AFB is the landing site for the first several Shuttle orbital test flights.

The George C. Marshall Space Flight Center (MSFC), Huntsville, Ala., is responsible for the development, production and delivery of the Orbiter main engines, the solid rocket boosters and external tank for the hydrogen/oxygen fuel.

The 747 Shuttle Carrier Aircraft Tests and the Orbiter Approach and Landing Tests will be conducted at the Dryden Flight Research Center, Edwards, Calif.

SPACE SHUTTLE PROGRAM OFFICIALS

DR. MYRON S. MALKIN is the Space Shuttle Program Director located at NASA Headquarters. Named to this post in April 1973, he heads overall design, development and testing of the Space Shuttle. Dr. Malkin joined NASA after serving as Deputy Assistant Secretary of Defense for Technical Intelligence Evaluation for almost one year. He was president of NUS Corp., an engineering consulting firm, from 1969-71, and earlier held positions as program manager for Titan II and Minuteman III. He was general manager of the Manned Orbiting Laboratory (MOL) program at General Electric from 1961-69. Dr. Malkin was born in Youngstown, Ohio and received B.S., M.S., and Ph.D. degrees from Yale University.

ROBERT F. THOMPSON, the Space Shuttle Program Manager, is located at the NASA Johnson Space Center (JSC). He is responsible for the overall management and integration of all elements of the program. Thompson was appointed to this position in 1970, after serving as manager of the Skylab program through the conceptual design and development phases. He joined NASA's predecessor organization, NACA, in 1947, and was selected as one of the early members of the Space Task Group, the nucleus of JSC. He was chief of the Landing and Recovery Division for Mercury, Gemini, and early phases of the Apollo program, prior to managing the early Skylab effort. He is a recipient of NASA's Outstanding Leadership, Exceptional Service and Distinguished Service medals. Born in Bluefield, Va., Thompson graduated from Virginia Polytechnic Institute with a B.S. in aeronautical engineering.

AARON COHEN is manager of the Space Shuttle Orbiter Project located at NASA's JSC. He is responsible for design, development, production and testing of the Orbiter. He joined NASA at JSC in 1962 as a member of the Apollo Program Office and subsequently held varied executive posts in the program. He was appointed Command and Service Module (CSM) manager in 1970, directing CSM efforts on both Apollo and Skylab programs until his appointment to the Space Shuttle post in 1972. Cohen has earned two NASA Exceptional Service Awards, the NASA Certificate of Commendation and the NASA Distinguished Service Medal. Born in Corsicana, Tex., he has a B.S. in mechanical engineering from Texas A&M and an M.S. in Applied Mathematics from Stevens Institute of Technology.

DONALD K. SLAYTON is manager for the Approach and Landing Tests Space Shuttle Program Office at JSC. He has overall program responsibility for managing the approach and landing test efforts and is responsible for integration of these activities at JSC, KSC and DFRC and other NASA Centers as required. Slayton was docking module pilot during the Apollo Soyuz Test Project in July 1975. He joined NASA as one of the original seven astronauts in 1959 and until his assignment to the ASTP crew, served as Director of Flight Crew Operations at JSC. He is the recipient of two NASA Distinguished Service Medals, the NASA Exceptional Service Medal, the Collier Trophy and numerous other honors from universities and organizations. A native of Sparta, Wis., Slayton is a graduate of the University of Minnesota where he received a Bachelor of Science degree in aeronautical engineering.

DR. ROBERT H. GRAY was named Space Shuttle Projects Office manager for NASA's Kennedy Space Center (KSC) in July 1973. He manages Space Shuttle operations planning, facilities preparations leading to launch, landing activities and refurbishment of the craft. Earlier, Dr. Gray was KSC deputy director of Launch Operations and director of Unmanned Launch Operations, directing more flights (178) than any engineer in the free world. He joined NASA in 1958 after three years as the Vanguard Launch Director and Deputy Manager of the Vanguard Group at Cape Canaveral for the Naval Research Laboratory. Gray was named chief of Goddard Space Flight Center Field Projects Branch in 1959, a post he held until going to KSC in 1965. Honors accorded Gray include the Navy's Outstanding Performance Award for the Vanguard program and from NASA the Distinguished Service Award and the Exceptional Service Medal. Gray graduated from Allegheny College, Pa., with a B.S. in physics and received an honorary Doctorate of Science from Allegheny in 1968. Dr. Gray was born in Cambridge Springs, Pa.

ROBERT E. LINDSTROM has been manager of the Shuttle Projects Office at NASA's Marshall Space Flight Center (MSFC) Huntsville, Ala., since March 1974, after serving as deputy manager for the preceding two years. From 1970-72, he was deputy director of MSFC's Process Engineering Laboratory. Prior to 1960, he was with the Army Ballistic Missile Agency as a Saturn project engineer and as project engineer for the Jupiter C vehicle which launched Explorer I. He joined MSFC in 1960 as manager of the Saturn 1-1B program. Lindstrom left government employment in 1963, to serve in top posts in industry but rejoined MSFC in 1970. He holds numerous awards, including NASA's Exceptional Service Medal and the Director's Commendation Certificate. He was born in Sycamore, Ill., and received a B.S. in ceramic engineering from the University of Illinois.

GEORGE B. HARDY is manager of the Solid Rocket Booster project, Space Shuttle program, for MSFC. Earlier he served as manager of the Program Engineering and Integration project, Skylab program; assistant manager of the S-1B Launch Vehicle project; and deputy project manager for S-1-1B Stage Project in the Saturn program. Hardy began his professional career in 1952 with E. I. DuPont in Georgia; he moved to the Redstone Arsenal in 1958 and transferred to MSFC in 1962, as a project engineer. He is a native of Russellville, Ky., and graduated from Georgia Institute of Technology in 1952 with a B.C.E. in civil engineering.

JAMES B. ODOM is manager of the External Tank project, Space Shuttle program, at NASA's MSFC. Odom began his professional career in 1955, with Chemstrand Corporation, Decatur, Ala. He moved in 1956, to the Army Ballistic Missile Agency and in 1959, joined the organization that became MSFC in 1960. He has been associated with Earth satellite programs, lunar unmanned probes and the Apollo program. A native of Georgiana, Ala,, Odom was graduated from Auburn University with a B.S. in mechanical engineering in 1955.

JAMES R. (BOB) THOMPSON, JR. is manager of the Space Shuttle Main Engine Project at NASA's MSFC. He served earlier as chief of MSFC's Man/Systems Integration Branch, Astronautics Laboratory. Thompson joined the propulsion research development team at MSFC in 1963, where he was responsible for component design and performance analysis of the engine system on Saturn launch vehicles. He is from Greenville, S.C.; and is a graduate of the Georgia Institute of Technology (1958) and the University of Florida (1963), with a B.S. in aeronautical engineering and an M.S. in mechanical engineering. He is seeking a Ph.D. in fluid mechanics at the University of Alabama.

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